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THE RELATIONSHIP BETWEEN THE INTERMEDIATE MEDIUM AND THE TRANSFORMATION AND CONTRAST PHENOMENA

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CHAPTER 1

The contragredient relationship between the clearness of the spatial intermedium and the magnitude of the transformation.

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In the color investigations made at this institute and published in a series of reports, we have not yet discussed the intermediate medium which occurs between visual objects. Because of the relationships derived in these reports, it is now necessary to give a detailed description of the intermediate medium, which represents an essential link and without which the discussion cannot be concluded.

This paper deals with the relationship between the optimal intermediate medium and the transformation and contrast phenomena.** By a transformation, we use the definition given by Jaensch. The transformation is the subjective brightness and color changes which occur for abnormal illumination, either for colored light or under shade conditions. By an intermediate medium, we understand the way in which the empty space between the visual objects appears. The intermediate medium is colorless, as clear as glass or as

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* Numbers in the margin indicate pagination of original foreign text.

** See the previous works of Jaensch, Jaensch and Müller, Kroh and Herwig in this journal and in the Zeitschrift für Psychologie.

bright as water in general and under normal illumination conditions. It is slightly colored for abnormal illumination conditions. /216
For shade conditions, it is colored dark gray or black. For colored illumination conditions, it is colored. Its coloration is never well developed and differs only slightly from the color of clear glass. High degrees of saturation, such as occur for surface colors, do not occur in an intermediate medium. The way in which the intermediate medium appears depends not only on the properties of the colored light source, but also on the surrounding objects, as well as the way in which the observation is carried out [1].

The finding by Schumann that the intermediate medium appears as clear as glass (Schumann' Investigations on the Psychological Basic Problems of Depth Perception, Zeitschr. f. Psychol. 85. 1920) agrees with the findings of Jaensch. Jaensch only discussed those cases in which the intermediate medium deviates from the appearance of clear glass. At the same time he stresses that in this normal case, the intermediate medium will always have an appearance which is close to the appearance of clear glass to a greater or lesser degree. We are not able to discuss this in any more detail as the results appeared after we had finished our investigation. For clarity, we will first give the main results of our own investigation. We found that the degree of transformation is closely related to the way in which the intermediate medium appears. The more the intermediate medium becomes decolorized and has the appearance of clear water, the greater will be the transformation and vice versa. All experimental conditions, which have the effect of increasing the transformation, also make the intermediate medium become decolorized and make it approach the appearance of clear water.

In the case of transformation experiments, usually a normally illuminated and an abnormally illuminated space is given.

Depending on the external experimental conditions as well as on the external and internal behavior of the test person, the normally illuminated and the abnormally illuminated spaces will receive more attention by the test person and will therefore dominate his consciousness. We must consider the fact that the perceived field of view propagates in the mental picture of the test person and is supplemented by him. There are cases in which one of the two spaces, for example, the normally illuminated / 217
space, only exists in the mental picture extension. For example, when stereoscopic images are observed and colored glasses are used, one can have the impression that the picture space illuminated with colored light is located inside a normally illuminated space, and that this normally illuminated space, which is the product of mental picture extension, can dominate the test person's consciousness to a greater or lesser degree. These investigations were always carried out during the middle of the day, because at this time there is the least amount of change in the illumination conditions. We use the following experimental installation.

The background was covered with gray paper and is divided into two parts H_1 and H_2 by means of a screen, S. H_1 is turned to the window and exposed to normal daylight. H_2 is in the shade. The preliminary investigation is first done according to experiments by Katz and Jaensch on transformation phenomena. Using a double screen D, which only has a small opening to both sides and which does not make it possible to observe the illumination conditions, a color top K in front of H_1 is positioned in such a way that it has the same objective brightness as H_2. In other words, it sends out the same light mixture as H_2 to the eye. I adjusted this myself before and after the observations which I will now describe and made by the test persons. I found them to be the same before and after each experiment (except for very

small differences and only in a few individual cases). After removing the double screen, H_2 appears brighter than K. "The transformation which occurs under the influence of different illuminations always has the following behavior. If we consider the disc (to be replaced by "side" here) in the shade, we would say that this disc (side) is in the shadow and is in reality brighter (i.e. closer to white) than it appears to us. These considerations then influence our consciousness. The phenomena have the appearance of a reflection. This does not at all mean that this reflection indeed takes place" (Jaensch).

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I personally arrived at this objective point of view, in order not to influence the evaluation by the test persons. They were supposed to evaluate the impression after removing the reduction screen. They were then asked to subjectively adjust the top K so it would have the same brightness as the background H_2. (If there was a gray color free of tones along the shadow side, then in most cases it would be necessary to add a yellow sector to the top). We observed the intermediate medium, which fills in the space delimited by S and H_2.

These statements are in agreement with the observations described by Hering [2], Jaensch [1], L. von Karpinska [3], Petroniewics [4]. Many statements by the test persons have the same content as the no doubt oldest description given by Goethe [5]: "The space which we think of as being empty has the property of transparency. If the space is now filled in in such a way that our eye does not notice the fact that this space is being filled out, then a material and transparent medium is produced, which is more or less corporeal and which can be air-like, gaseous or liquid." A corresponding remark of Hering is, "During the day we look upon the so-called empty space between the observer and the visual objects in an entirely different way as during the night. The increasing darkness extends

not only over the objects, but also over the space between outselves and the objects. Finally it covers them completely and it exclusively covers the space. If I look into a dark box then I will observe that it is filled by darkness. It is not just observed as a dark coloration of the walls of the box. A corner in the shade within an otherwise bright room is full of darkness which is not just localized in the limiting surfaces of the corner but also in the space which it encloses."

Jaensch found that the statements of Hering need a restriction. It depends on the behavior of the observer whether and to what degree this filling up is observed. He established / 219 [1] that the impression of an intermediate medium is intensified if perpendicular lines are installed in the space. This means that attention is drawn to a point located in the space and not through the limiting walls which usually occurs. In open country, for example, we can observe that the air in front of a forest has the appearance of haze color in an undetermined way, if we behave in a natural manner. However, as soon as we direct our attention to the individual tree trunks, the air becomes as clear as glass.

In the first configuration, I wanted to make the test persons direct their attention to the limiting surfaces. This is easier to do if the limiting surface has details than if it is homogeneous. This is why we had gray disks (Sch) mounted on the shaded background. They had the same color as the background. In one case the disk was mounted directly on the background. After that, a disk was mounted 1.5 cm from the background H_2. Both disks installed in this way were observed in sequence through a reduction screen. Their brightness was then adjusted on the top. In a second configuration, the homogeneous background H_2 was observed without the disk. According to the

test persons, their attention was directed much less to the limiting surfaces. In the experiments with the reduction screen, we always had the same adjustment for the disk protruding from the background, the disk on the background and for the background alone. Subjectively, the disk appeared somewhat brighter than the background (having the same brightness as the disk). The background again appeared considerably brighter than in the case where it was observed without a disk. Objectively, all these brightnesses are the same, even though they appear to be different. In both cases with the disk, for the disk on the surface as well as protruding from it, the intermediate medium was not observed as clearly and in one case, the test persons stated that it had disappeared completely. In other words, the darkness filling the space had the appearance of clear glass. In a comparison configuration in which the homogeneous background was observed exclusively, the dark intermediate medium became clear. /220

We will now give a more detailed description of the experiments.

Using the color top K, we determined the apparent brightness of the homogeneous background of the disk on the surface as well as of the disk protruding from the surface. The impression that the object had become brighter was stronger for some test persons in the case of the protruding disk, than was the case for the disk on the surface. For some test persons, the impressions were the same. It was never less. The disks were installed at the same height and had the same distance to the separating screen as the color top K located on the side having normal illumination. Accordingly, in the comparison configuration with the homogeneous background, we adjusted the apparent brightness of the region of H_2 symmetric with respect

to K on the top K. According to statements by the test persons the top was adjusted to the same apparent brightness as that of the disk. The experiments with the homogeneous background were always performed first and the adjustment from them was retained on the top when the disk experiments were started. The test persons were surprised that in this way the top K could become "darker" than a disk on the other side. In spite of the differences in illumination, in most experiments we were not only able to adjust the same brightness, which was the main point in these experiments, but also the same approximate color. We used four different nuances of gray, including white. The test persons were the ladies Burgdorff, Dietschold, Holstein, Ullmer and Mr. Richter.

All test persons essentially made the same statements. That is, if the disk is installed, the darkness disappears and one can look through the medium in a clearer way. "It is though a veil has been removed if a disk is installed." "The mist is removed and goes to the side." Other statements said that the mist goes "to the corner", the air becomes "transparent" and "as clear as water".

Just as in the case of Katz [6] we measured the degree of transformation using the quotient of the white values obtained for settings corresponding to subjective and objective equality. The objective values were obtained during the preliminary experiment. /221

The stimulus value of 60° cloth black is set equal to 1° white. The white valences of the colored papers are taken into consideration in the calculation. We will use the following abbreviations: obj = objective setting, i.e. setting with double screen (always drops out for the homogeneous background, the disk on the background and the protruding disk).

All other settings occurred without the double screen.

We use the following notation.

h. G = setting of the homogeneous background.
m. Sch. = setting with disk on the background
m. a. Sch. = setting with protruding line.
W. = white, S. = Black, G. = Yellow.

Q. h. G. = Quotient of the value for h. G. and obj., that is, for the case where there is no disk on the background.

Q. m. Sch. = The same quotient for the case where the disk is right on the background.

Q. m. a. Sch. = The same quotient for the case where the disk protrudes away from the background.

We will give a list as an example of data obtained during the many experiments.

TABLE I.

	obj.			h. G.			m. Sch.			m. a. Sch.		
	S.	W.	G.	S.	W.	G.	S.	W.	G.	S.	W.	G.
1.	310	18	32	265	71	24	258	78	24	250	86	24
2.	320	18	22	264	68	18	255	86	19	227	115	22
3.	345	6	9	318	32	10	304	47	9	298	62	10

We obtain the following total white valences:

	obj.	h. G.	m. Sch.	m. a. Sch.
1.	31,1	81,4	88,3	98,1
2.	28,8	80,9	95,2	124,3
3.	13,9	39,8	54,2	69,2

and the quotients of the white valences:

	Q. h. G.	Q. m. Sch.	Q. m. a. Sch.
1.	2,6	2,8	3,1
2.	2,7	3,3	4,3
3.	2,8	3,8	4,9

The formulas show that Q. h. G. is always smaller than Q. m. Sch. and that Q. m. Sch. is again smaller than Q. m. a. Sch. (or at most equal in some individual observations). In other words, by adding the disk, the subjective brightness and therefore the transformation become significantly greater. It increases more for the protruding disk than for the disk on the surface.

At this time the gray background was observed using colored illumination. First red-yellow light was used (aurantia yellow). The installation was the same otherwise except that a light source (L) was installed obliquely with respect to the gray background. A cuvette containing colored liquid (Kü) was placed along the path of the light beams. /222

The test person again had to make a judgment based on appearances only and while suppressing all reflections. A red-yellow intermediate medium was observed ahead of the side with the colored illumination. However, it almost disappeared as soon as a disk having the same properties was placed on the background which was initially homogeneous. We always used a protruding disk. A decoloration occurred immediately in this case as well. The intermediate medium and the space were almost seen through completely. Before the experiments, an objective setting had been obtained using the double screen. If the homogeneous background was then adjusted at the top without the double screen, the white valence was increased and the colored valence was decreased, i.e. there was a decoloration in addition to brightening.*

* This is because the colored light is not as bright as the daylight on the other side, so that the brightness transformation is subjected to quite similar conditions as described earlier for the shadow in one field.

This last phenomenon became clearer when the disks were installed. The disk became distinct from the background as far as its apparent coloration was concerned, and it seemed brighter even though in reality it was equivalent to the background. We always had the impression of a gray background under colored illumination conditions. When the disk was present, the intermediate medium could not be seen as well. We again obtained an appearance corresponding to bright water. However, we will only give a quantitative result here because all experiments gave similar results. When we specify the "colored valences" we are summarizing the red and yellow results. /223

TABLE II

	obj.				h. G.				m. a. Sch.			
	S.	W.	R.	G.	S.	W.	R.	G.	S.	W.	R.	G.
1.	33	47	127	153		107	38	215	41	147		172
2.	54	50	131	125	76	121	27	136	57	175	38	100
3.	71	29	119	141	98	104	41	117	65	167	36	93
4.	86	46	86	142	111	87	30	133	96	160	21	83

The white valences:

	obj.	h. G.	m. a. Sch.
1.	117,5	170,2	190,4
2.	90	163	210,5
3.	95	145	202,2
4.	102,5	122,9	187,5

The quotient of the white valences:

	Q. h. G.	Q. m. Sch. = Q. m. a. Sch.
1.	1,4	1,6
2.	1,9	2,3
3.	1,4	2,2
4.	1,2	1,8

The colored valences:

	obj.	h. G.	m. a. Sch.
1.	280	253	172
2.	256	163	138
3.	260	158	129
4.	228	163	104

The quotients of the colored valences:

	Q. h. G.	Q. m. Sch.
1.	0,9	0,6
2.	0,6	0,5
3.	0,6	0,4
4.	0,7	0,5

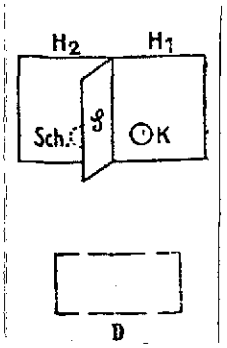

Figure 1.

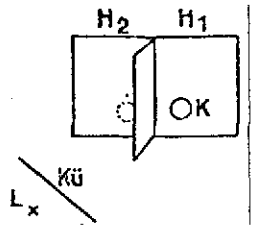

Figure 2.

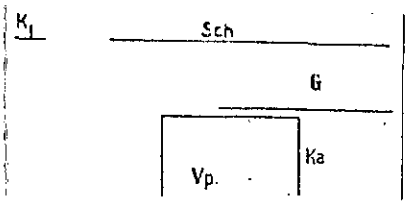

Figure 3.

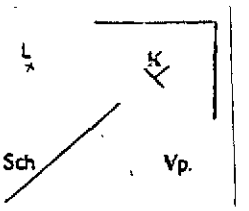

Figure 4.

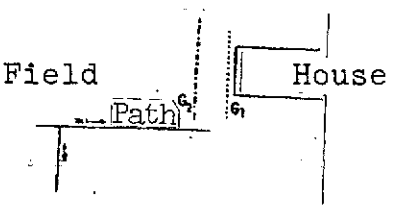

Figure 5.

The investigation with the red light led to completely equivalent results: subjective brightening and reduction in the coloration. Both phenomena are considerably more intense when a disk is present, i.e. if the attention of the test person is held by the background. In the case of the quotients of the white valences, again Q. H. G. is smaller in each case (or equal in an extreme case) than Q. m. Sch, i.e. the brightness transformation without the disk is smaller than in the case with the disk. As far as the quotients of the colored valences are concerned, Q.h.G. is larger than Q.m.Sch, i.e. the subjective decoloration or color transformation is less without the disks than with the disks. However, the increase in the transformation is always coupled with a disappearance of the intermediate medium.

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The following experiment will show how the intermediate medium disappears in parallel with the intensified transformation. In this experiment, gray top disks (18 cm diameter) were formed by black/white sectors and were observed in the shaded space. When 360° white was observed, an intermediate medium was observed. However, the test persons called it "very unclear" and sometimes "very thin". "Just like water with a slight degree of turbidity." When we set the value 270° white, the intermediate medium became clear. When the setting was 180° white, the medium became even more dense. When the 360° cloth black was set, the darkness in front of the disk became even clearer, according to the statements of some test persons, it was "body-like". The results of Katz as well as those of Jaensch and E. A. Müller [7] had contained the following information: "The apparent brightness change which occurs due to the influence of the transformation is intensified, the brighter the disk is made." On the other hand, according to the experiments being described here, we find that a denser medium is observed in front of a dark disk than in front of a gray disk. The medium is denser again in front of a white disk.

Overall, we might say that the clearness of the intermediate medium decreases as the brightness of the disk is increased. This means that experimental conditions which increase the transformation at the same time bring about a decrease in the clarity of the intermediate medium. Therefore, we find that our experiments again confirm the following statement: The intermediate medium appears clearer, the smaller the transformation. The intermediate medium comes closer to the appearance of clear water, the greater the transformation. Of course we were only able to carry out qualitative experiments on the way in which the intermediate medium became clear and then unclear again.

In agreement with the result that the intermediate medium appears clearer in front of the dark disk, we have the observations which were described by Jaensch and which deal with the influence of the background on the intermediate medium as well as the influence of the color present in the visual field. /225

The coloration of the intermediate medium depends on the color which is dominant in the field of vision. (Previous reference, Page 281), and this means that the darker disks also bring about darker coloration of the intermediate medium. Hering also stressed the fact that the brightness of the intermediate medium depends on the brightness of the surrounding objects. Outside I have often made the observation that the air around the willow crowns surrounding red or red-brown willow branches clearly appears colored just like the branches. In the vicinity of the branches there is a red-brown coloration of the air, which becomes less and less saturated in the far surroundings. It finally gradually decays and takes on the appearance of clear water. In this case, the color of the willow dominates in the field of vision. We can also observe that a gleaming object in a snow landscape seems to radiate into space.

Katz changed the conditions of the transformation experiments somewhat and obtained various degrees of transformation by varying the observation conditions. We varied the conditions in a corresponding way and observed the intermediate medium. The test persons, the same ones used in the other experiments, already had some practice in describing the color phenomena which occurred. We again used the shadow arrangement shown in Figure 1. However, a variable color top was now also located on the shaded side.

First I transferred from the binocular observation method to the monocular observation method. With the monocular observation method, the shaded space appears darker and the intermediate medium appears denser. The same result is obtained for a superficial observation. When transferring from the binocular to the monocular observation method, the clearness of the intermediate medium increases. It is as if "the darkness has come out of the walls". The regression of the intermediate medium is even clearer during the transition from the monocular to the binocular observation method. According to the experiments of Katz, the results of which we were able to confirm, the transformation is more intense for the binocular observation method than for the monocular observation method. Again the increase in the transformation and the regression of the intermediate medium run in parallel. /226

After this, the intermediate medium in front of H_2 was observed with indirect observation conditions. The test person had to fix his attention on a rod, which was installed to the side of the top. Again the intermediate medium became darker and clearer at the same time. According to the results of Katz, the brightness transformation for side viewing conditions of the shaded disk decreases, but at the same time the clearness of the intermediate medium increases.

Finally the shaded arrangement was observed at various distances. The intermediate medium became clearer at large distances and the transformation decreased. "The farther away I am from the wall H_2, the darker it appears to be. The darkness which fills the space is especially dense in the vicinity of the background. If I come closer, the dense darkness moves towards me and is distributed more so that now everything appears brighter, the space in front of the background as well as the background. The medium at a small distance is no longer as non-transparent." (Miss Hammerschlag). The further away one moves from the installation, the more the illuminated space dominates and one tends to abstract less from the abnormal illumination conditions.

When observations are made from the side of the head, the depth perception of the experimental installation decreases and therefore becomes similar to observations at large distances.

When viewing out of the side of the head, the intermediate medium is clear and the transformation is smaller. All of these experiments showed that the transformation decreases if the clearness of the intermediate medium increases.

CHAPTER 2

The importance of the dominating space for the appearance of the intermediate medium and the magnitude of the transformation.

The importance of the dominating space is especially clear during stereoscopic experiments. In such experiments, two internal adjustments are possible. First of all an adjustment to the image space can be made and then an adjustment to the space

in which the observer is located, called "the real space" for abbreviation here. The latter case corresponds to an observation box. We must always consider the fact that the space /227
actually observed is propagated in the test person's imagination. This explains a large part of our experiments. It was Exner [8] who described the propagation of the perception space into imagination space. Also he showed that what is actually observed is considerably modified by imaginative additions, which can lead to changes [8]. The females Buresch, Cramer, Haas, Hammerschlag, were used as test persons. First stereoscopic images were used which contained snow landscapes (from the Alps). In the first case we used landscapes which had an extensive foreground, which were more or less homogeneously distributed with snow and which had houses, trees and persons in the background (I). In the second case we used landscapes in which significant objects were located in the foreground (II). In the third case we used landscapes in which the objects were uniformly distributed over the foreground and the background (III).

All the pictures have the same tint*. There was a colored and first a blue glass plate between the glasses of the stereoscope and the images placed behind it. This meant that the objects were observed just like in a room with blue illumination. This means that they were imbedded in a blue intermediate medium. The test persons all said that the snow appeared white. They said that it appeared white to a greater or lesser degree of purity for the blue illumination conditions, i. e. for a blue

* Because of the differences in the experimental conditions during these observations, we were not able to give an exact physical formulation. Jaensch and Reich pointed out that physical exactness often does not correspond with psychological exactness. Often simple physical conditions correspond to complex psychological conditions, and complex physical conditions correspond to simple psychological conditions (Zeitschr. f. Psychol. 86).

intermediate medium. However, the white was the purest for the pictures in which the objects in the foreground contrasted in a plastic way with respect to the snow. (II). The white on the pictures with a homogeneous foreground and objects along the background only (I) appear to be the least pure.

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The pictures in which the objects were uniformly distributed over the foreground and the background (III) held an intermediate position.

Up to now, the test person had focussed his attention on the space of the picture which is usually the case for unforced observation. At this time the test person was asked to be aware of the fact that these were only pictures, which were observed in a viewing box and that they are not located in the object space but in the "true" space of the room in which the observations are being made. When the test person observed the pictures with this frame of mind, the objects shown in the picture took on a stronger blue color and they lost their space-like character, at least according to indications by a few of the test persons. This phenomenom was best observed with the pictures having a homogeneous foregound (I). In the case of the other pictures, it was especially difficult to make this adjustment, but in this case it was also immediately possible when the stereoscopic pictures were raised between 1 and 2 cm, so that part of the "true" space became visible.

With these changed conditions, the other pictures were also observed. For these pictures, the internal readjustment was enough to make the intermediate medium disappear partially or even completely and to relocate the color to the objects shown in the picture. In this type of experiment, the coloration

was even more pronounced for pictures (I).

If the observer of the pictures having a homogeneous snow foreground directs his attention to this foreground and does not observe the objects located behind it, then the blue also is transferred to the background, which is similar to the idea that the observer is located not in the picture space but in the "true" space. When this homogeneous snow foreground is observed, the blue is in the plane of the picture but it was not possible to locate this plane. Instead the observer has the impression of an "area color". This is even more pronounced as the foreground becomes more homogeneous. For some pictures the snow was represented by a homogeneous white color. In other pictures it was granular and not flat. This factor made the type (I) pictures similar to the types (II and III) pictures. This made the observation of a blue coloration of the snow more difficult and instead gave the impression of white snow under blue illumination conditions. If the test person observed a completely homogeneous white paper which was only slightly granular (ordinary white drawing paper), then a blue surface coloration appeared which was related to the area coloration. The test person then no longer had the clear impression * to be in the picture space but instead to be in the true space. If the granular white paper was replaced by smooth cardboard, then the surface color came even closer to the area color and this color was closely related with the three-dimensional space color. /229

In the experiments described, the blue glass plate was 8 cm behind the glasses of a stereoscope. The observer had a clear space impression if the pictures were at a distance of between 15-18 cm (depending on the test person) from the stereoscopic glasses. When the pictures were positioned slightly farther away

* There are transitions between the two appearance types.

or if they were brought in closer (24-26 cm or 8 cm from the stereoscopic glasses) the intermediate medium disappeared. The color again is transferred to the objects in two different ways. When the pictures had been located too far forward, a dark and quite saturated blue developed on the background. If they were moved back too far, the blue was brighter and was greatly mixed with gray. In both cases, the color of the background was closer to an area color than to a surface color. When the blue glass disk was placed directly on the pictures at a distance at which they in general had the best space effect, the impression was similar to out-of-focus pictures at a distance of 8 cm from the stereoscopic glasses. A background was observed which was quite saturated and the depth effect was smaller.

When the snow pictures were reversed, this did not affect the way that they appeared, even though the represented objects had a very plastic appearance. It was only for the non-plastic pictures that the color of the intermediate medium again was transferred to the objects when the pictures were reversed. Pictures of other landscapes and inner spaces did not contribute anything new. Just like for the snow pictures, an impression of a colored intermediate medium was obtained which became clearest when significant objects were located in the foreground. Only a few objects or sometimes only one object /230 were necessary for this to occur. For example, in one picture there was a bridge approximately in the center of the picture. There was a tip of a pine tree in the extreme foreground which intensified the impression of a colored intermediate medium.

Observations through red and green colored glass did not result in any noticeable differences from the observations described earlier. However, in this case the impression of the colored intermediate medium was not as good as for the blue glass, apparently because the red and green colors were not

as natural. It was a little easier to displace the color into the picture area.

Of the many possibilities, it is perhaps important to mention the one in which rice powder was placed on the colored glass plate. In this case the test persons stated that the color is again displaced more towards the surface. When the attention of the observer was focussed on the picture space, the turbidity was considered as a mist. This was more easily done for landscape pictures than for inner spaces.

When the illumination was reduced, it was always easier to observe the color on the picture surface. The depth sensations became less clear because of the reduction in the illumination level. The entire picture approaches the case of the homogeneous snow surface (I) and was therefore observed in a similar way.

The following experiment is a variation of the observations just described. In these experiments, the consciousness of the test person is focussed on the normally illuminated "true" space. Another time it is focussed on a space illuminated by colored lights. The test persons included the females Hammerschlag, Holstein, Kleimenhagen, Zbylitzki and the males Broer, Prof. Jaensch, Wiepgen. The following experimental installation was used.

A white screen (Sch) was used on which the same white disks could be hung. Next to this, there was a colored top (K) at a large distance to the side. The test person was located about 1 1/2 m from the screen and observed through a box (Ka), which had a horizontal cut and was built such that it was in complete contact with the face.

The walls of the box were covered with black paper. There /231
was a glass plate (G) along the front wall facing the white screen which could be displaced on a rail in a horizontal direction. The test person placed his head against the box during the observations. In configuration I the glass disk completely closes off the cut-out of the box. In configuration II the glass disk is pulled out somewhat, so that about 2 cm of the horizontal cut-out is not covered.

Observations were first made with a blue glass plate. In the case of configuration I, a space filled with blue light appears. In the case of configuration II, the color seems to be closer to the surface. It is difficult to give an exact description of the impression. This blue color makes contact with the white color along the side. The white color is observed through the free part of the cut-out. It is difficult to give a closer description of the color in this case because, strictly speaking, it is not a surface color, but seems to be a kind of transparent color. There seems to be a transition between the transparent and the area colors, just like there is a transition between the surface colors and the area colors.

Professor Jaensch wrote the following statements. In the case of configuration I: "A blue intermediate medium is clearly observed, which is the densest on the background. This is especially the case if the observer views the screen back and forth without any constraints, and for the binocular observation method. The disk itself is slightly blue, in the sense of a blue surface color, and not only in a sense of an intermediate medium on top of it."

In the case of configuration II: "The color is localized differently but it is difficult to describe. If we note the

white slot, the color impression is similar to the impression for surface colors. This means it is similar to the case where 1/2 of the field is white and the other is colored blue. However, the phenomenon is not exactly the same as for a surface color. Apparently there are transitions between the case of a space illuminated with colored light and a surface color. Apparently such a transition exists here. For this configuration (that is, in the case of a slot) the space character of the color is greatly decreased but does not disappear entirely. The surface character is intensified so that there is a transition case between the surface color and the illumination color here and the former predominates greatly. /232

"The more it becomes possible to have the observer give his attention to both the slot and the colored part of the field of vision, the more the surface character and therefore the coloration will predominate. This is especially the case when the separation line is fixed, and the white and colored part are viewed indirectly. Strictly speaking, the blue color is also different from the surface color because it is not localized in the same plane, at least as far as the surface color is concerned as would be the case if observed through the empty slot, which is the white part of the screen. It is difficult to state how it is localized exactly. One has a clear impression that it appears behind the glass plate. Certainly there is no blue illumination in front of the plate (this difference between the coloration of a part of the space in front of and behind the glass plate does not exist in configuration (I), that is, for observations without the slot).

"The more the observer concentrates his intention on the part of the screen observed through the glass disk, the more he will have the impression that the blue part is closer than the

white part. When both paths of the field of vision are observed simultaneously, the impression of uncertainty regarding the distance predominates."

The other test persons also said that behind the glass plate they had observed a space which looked like it was illuminated by blue light. Miss Kleimenhagen stated that the white paper disk is blue with more gray than the same background. On the other hand, Mr. Broer did not notice any difference between the two. Just like in the experiments described in the first chapter, the intermediate medium was not as clear as soon as the background was made more inhomogeneous by installing the disks, even though the decrease was not as great as in those experiments.

As soon as the slot was present (configuration II), the blue intermediate medium was pushed back even more, and the surface color itself did not become visible. All test persons stated that in configuration II the blue is much more saturated. This was also found in the quantitative adjustments. /233 In order to avoid adaptation, the observations all were made only over a short time.

The test persons were asked to clearly remember the colors they observed and to then close their eyes. After removing the box, the remembered color was then adjusted on the top to the side. Some of the experiments will be given on Page 24.

In all cases, there was greater coloration in the case of configuration (II) and less brightness at the same time. The adjustment was not very easy for these experiments, because the color observed through the glass plate has a completely different character than the top. This is why the same colors were not adjusted, but colors were adjusted with approximate

Test Person

Miss Kleimenhagen

Configuration I				Configuration II			
Bl.	W.	S.	R.	Bl.	W.	S.	R.
225	135			260	80		
		Test person- Mr. Broer					
200	64	96		335	25		
		Test person - Mr. Wiepgen (asked for a red sector)					
275	67		18	302	40		18
		Test person - Miss Hammerschlag					
230	130			277	83		

correspondence of the color tone brightness and saturation.

When red light was used, the observers sometimes stated that they only observed "in the red" and had a purely spatial "object-free" color impression (Miss Burgdorff). When a white disk was installed, this spatial character disappears somewhat but does not disappear entirely. In the case of configuration II, the saturation becomes greater again. Similar experiments were carried out with a green glass plate. The intermediate medium was not as clear, in spite of the good saturation of the green plate. The color no longer is applied to the background. In contrast to this, the color of the intermediate medium was the clearest for the blue color. This difference is probably due to the fact that green illuminations are much rarer in nature than are red and blue illuminations. These colors occur during evening dusk or as colors of objects at a distance. Conversely, green areas are much more abundant in nature than blue and red areas.

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In the case of the experiments described in Chapter 1, the intermediate medium disappeared just like a haze disappears. The intermediate medium disappeared without being applied to the available areas and surface colors. In the experiments with the box, on the other hand, and when the slide was pulled out, it appeared as though the color of the intermediate medium became applied to the white area. At the same time the air again became transparent and it was possible to see through it clearly.

CHAPTER 3

Phenomenological proof of the transition cases of a spatial intermediate medium and a surface color. Also transition cases of transformation and contrast phenomena.

All of these experiments have shown that the color which fills the field of view can appear as an intermediate medium, that is, as a spatial color or as a surface color or area color. The smooth transitions from the spatial color, i.e. intermediate medium, to the surface color or area color, respectively, will now be demonstrated by direct special experiments. A rotating colored disc is observed (using all the test persons used in previous experiments). This is done at various distances. The phenomena differ, depending on the difference between the test person and the top. At a distance of 1-2 meters, the test persons still had the impression of a clear surface color, that is, the impression of colored paper. This was the case if they fixed their attention on the edge or the center of the disk. When the test person moves closer to the disk (to a distance of about 30 cm), the localizations of the color became less clear and less determined. Just like for an area color, the test persons had the impression of being able to penetrate into the

space to a certain depth. This impression was intensified when the test persons gave their attention to the center of the disk instead of to the edges of the disk. In this case, the color appeared no longer to be localized in a plane. Miss Haas observed a concave curved surface at a distance of 1.5 m, and she was able to penetrate into it with her vision. When the test person came even closer to the disk, most of them had the impression of a space filled with color, that is, a colored medium similar to the intermediate medium discussed before. These observations were carried out with normal illumination conditions. /235
The rotating disk lost some of its surface character in these experiments. This was even more pronounced when the disk was illuminated with colored light. An experiment can show that, even if a colored disk is illuminated with white light, the test persons will have the impression of a space illuminated with colored light so that the air in front of the disk seems to be colored, just like the intermediate medium in the space illuminated with colored light. First I showed the test person a white disk in a corner illuminated with colored lights (blue, red, yellow, green). After the test person had observed the corner illuminated with colored light for some time, the main experiment started in another room. The females Burgdorff, Wiehe, Hammerschlag, Zbylitzki and Mr. Lachmund were used as test persons. They observed corners covered with colored paper. A color top having the same color as the paper on the walls was introduced into the corner. Sometimes it had a small white sector (20-100°). When the white light of an arc lamp illuminates the rotating top, then it appears as completely white to some test persons. Others say that it appears almost white and almost like in a room illuminated with colored light.

The test person was located close to the top (K) at a distance of about 30 cm. The arc lamp (L) was covered by a screen (Sch). The test person did not know the color of the

illuminating light, nor did he know the color of the top disk for normal illumination conditions. This means that he only evaluated his impression. Even though I knew the color of the disk under daylight illumination conditions, it was not possible for me to say anything else but that it was "white" in a space illuminated by colored light. Mr. Lachmund stated the following for the blue disk. "It is as though blue light falls on snow". Miss Burgdorff also stated that the blue disk was "snow white". This phenomenom was the clearest for the blue light and the weakest for green light. For example I, myself, in the case of green, had to add 130° white in order to obtain the impression of a completely white disk for colored illumination conditions. In the case of red and yellow (which are certainly not saturated any less), 70-90° was enough for this. In the case of blue, 20-40° was already enough. The intermediate medium observed in front of the disk is difficult to distinguish from the one observed in a space illuminated with colored light. At this point the /236 experiment was modified somewhat. A gray ring was placed on a blue top disk. The test person was only asked to evaluate the situation. A more precise formulation of the question would have amounted to a suggestion which was not desired. The test persons stated that the blue color did no longer fill the space as before. They said that the blue color was localized along the outer edge and the inner part, but not like a surface color but more like an area color. This means that one can penetrate into the color. Some test persons were surprised that the ring had not been illuminated with blue light. These statements already allowed us to conclude that the test persons believed they were observing a space illuminated with blue light in spite of the restrictions mentioned above. In the case of the disk with the ring, there is a similar phenomenom as the one which occurs for the box experiment in configuration II in which the box with the slot is used. In this case, the slot disturbs the homogeneity of the background and reduces the impression of the space

character of the color. When the ring is present, the blue is more saturated and no longer makes the impression that it is white in a blue light. Instead it becomes applied to the disk and approaches the area color more closely. The gray ring seemed to be covered by a slightly yellow veil. This experiment is similar to the previous ones. Just like the box experiment with the slot is similar to the box experiment without the slot.

The same experiments were carried out with red, yellow and green disks. They all led to the same result. The space character was suppressed somewhat in the case of the disks with the ring. The color is applied more to the disk and it was more similar to an area color than a surface color. The ring seemed to be covered with a light veil of each corresponding complementary color.

The impression of a space illuminated with colored light was also produced by the following experiment, which again demonstrates a transition phenomenon between the surface color and a transparent space color. (Test persons were the females Eichengrün, Haas, Hammerschlag and Mr. Richter).

A house could be observed through the windows of the observation room. The image of this house was projected on to a screen using a lens. The screen was covered with colored (red, blue or gray) paper. The house appeared to be completely white but had the appearance of being located in a space with colored illumination. For comparison purposes, the mere image was observed with a blue glass plate. The impression was almost the same. The space seemed to lie behind the plane of the paper. When the picture was sharply focussed by the lens, the impression of a space illuminated by colored light was very strong. The "plane" of the paper then had the appearance of a three-dimensional body. /237

We now observed the parts which had a white appearance through a small reduction screen, which only had a hole along the front and back side and which operated like a tube. When observed through this screen, the parts of the house wall which had previously appeared white, took on the color of the disk color but were slightly brighter. The corresponding points of the comparison mirror had a similar appearance under the same conditions. The picture became out of focus by slightly displacing the lens. In this way, the house also was observed to have the color of the disk. More accurately, the house was not recognized. Instead bright and dark parts were observed of the background, but none of them had a white appearance. The color of the paper came close to the appearance of the surface color.

I designed a parallel experiment for this case. In a darkened room I projected images on a rotating top by means of a projection device. First I adjusted a yellow top and projected the image of a blue square. The test person stated that there was a gray spot on the yellow. After this I projected the image of a child having a blue suit with a similar color and the color of the suit was observed to be blue on the top.

Both experiments show that, as soon as an object is recognized in a space which has a blue appearance, the colored projection surface becomes the intermediate medium and the transformation begins.

However, if no objects are recognized because of the homogeneous nature of the objects or the out of focus adjustment, the color becomes localized in the plane of the screen. The intermediate medium and the transformation do not occur then.

Professor Jaensch and his co-workers showed that there is a close/238 parallelism between the transformation laws and the contrast laws. He stated the following main theorem: "Fundamental laws for contrast become fundamental laws for transformation phenomena, if the term "surrounding field" in the contrast laws is replaced by "illuminated space". The reverse of this theorem also holds."

The parallelism of the laws leads one to believe that transition cases between the contrast phenomena and the transformation phenomena could be demonstrated on an appearance level.

In fact, our observations have demonstrated the relationship between the contrast phenomena and the transformation phenomena which, up to the present, has been proven by a parallelism of laws. Now we have a phenomenological proof of this.

For example, if contact experience can be demonstrated using the colored top, then its plane will serve as surrounding field as well as the close field. Both occur in the form of surface colors.

The observations described at the beginning of the chapter prove the fact that the colored top under suitable conditions can have both the appearance of a surface color as well as the appearance of an area color and space color.

This means that there are phenomenological transitions from the surrounding field to the surrounding space. The plane of the colored paper, which had the effect of an illuminated space when the house was projected on to it, is another example of this state of affairs.

In order to avoid misunderstandings, we would like to discuss an error which has occurred in the literature. A. Lohmann interpreted the communication by J. on the parallelism of the transformation and contrast laws to say that the colored intermediate medium has the effect of a kind of "edge contrast" according to J. He opposed this thesis of the occurrence of an "edge contrast in the third dimension". However, Jaensch did not advance this thesis. In contrast to this, from the beginning he clearly indicated that the transformation phenomena are not at all based on the surrounding contrast.

It will certainly be of interest to relate the experiments described in this chapter with the impressionist painters. Jaensch has discussed this in connection with the way in which the intermediate medium appears (The Perception of Space, 1911).

CHAPTER 4

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The relationships between the intermediate medium and luminosity.

If a color is observed through a different transparent color, a type of competition occurs. Either the color of the intermediate medium is clear or the intermediate medium becomes decolored and transformation occurs. In the case of a mirror, the observer sees right through the surface and the proper colors of the objects seen through it are observed. This is at least the case for usual "colorless mirrors". This is different for colored mirrors. In this case the color of the mirror becomes the intermediate medium.

If both points of view, the points of view of a mirror and of a surface attempt to compete too much, then the

luminosity phenomenon occurs. As Helmholtz [9] already pointed out, it is important to know that the light is divided into two portions. In the usual luminosity phenomena, the luminosity of the surface can be looked upon as an incomplete mirror image. This is why an undetermined amount of brightness passes through semi-transparent walls of a knife edge of a metal or of porcelain china. The competition of both points of view occurs here because the surface has a clear shape and therefore the observer does not see straight through it as he does with a mirror. On the other hand, there is again a tendency to see through the surface because of the penetration of the brightness behind it. If this competition is reduced in favor of one point of view by holding bright objects with contours in front of the shimmering surface instead of the "undetermined brightness" objects, then a mirror reflection is produced from the luminosity. This is because the image seen behind the surface now attracts the attention and this is why the observer sees right through the surface. In this case the intermediate medium seems to be limited in the front by means of a transparent surface, which more or less has the character of a transparent color.

Dove [10] already stated: "The consciousness of this unclear perceived mirror image produces an impression of brilliance." Baumann [11] also supported this point of view and demonstrated it by means of special experiments. He / 240
showed that a mirror becomes a bright surface if lycopodium seeds are spread over it. Baumann already pointed out that the competition is a prerequisite for brilliance.

The importance of the competition for the occurrence of the luminosity can already be clearly seen in stereoscope experiments, when a black and a white surface are united with a binocular. There is a constant change in the impression.

First the dark surface prevails and the impression is similar to a dark illumination. After that, one again observes bright spots. If there is no dominant color, but if there is equilibrium instead, then luminosity is observed instead of a dull gray. This phenomenon is quite apparent in the dodecader from the J. Martius-Matzdorffs collection [12], sheet 36. The same figure is shown to one eye in black on a white background. The other eye sees a white figure on a black background. On the other hand, if one eye is exposed to a figure having sharp contours and the other observed a homogeneous area, then the figure as well as the adjacent part of the background is dominant (Panum). For example in the case of sheet 11 of the collection mentioned above, there is a black star and a white background on the left and a homogeneous area on the right. On the other hand, for sheet 36, where both impressions were the same, the luminosity phenomenon occurred. Luminosity occurs when two visual objects are viewed in succession and when the front one has a tendency to approximate the appearance of empty space or of the intermediate medium and if this tendency cannot dominate because neither one of the two visual objects dominates.* (In particular, the rear object does not dominate.) The production conditions for luminosity can also be illustrated by the following observation first suggested by Professor Jaensch and which was then investigated in more detail. A road which runs along an open field along one /241
side was bordered by a wood fence on both sides. The fence facing the open field was black and the fence facing the house was white. (see Figure 5).

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* Additional remarks: Recently F. Kiesow attempted to prove that a sufficient degree of "independence" of both impressions is a prerequisite for the occurrence of binocular luminosity Arch. ital. di Psicol. Vol. 1, 1920, p. 3.

If the observer approaches the road along the path, then the white fence (G_1) appears approximately in the plane of the black fence (G_2). At least it does not seem localized too far away from it. The entire scene is similar to a luminous mirror surface. It is not as though the observer were looking through a transparent color to observe another color; instead both planes coincide. First the color of one object and then the color of the other object will dominate consciousness. When the observer approaches the road, he very clearly observes black and white spots which appear as random spots and which have the effect of light reflections. However, this is not a disordered and moving mixture of light and dark, as is the case in flickering phenomena. Instead there is a quiet and smooth changeover. One has the impression of a shimmering water surface. Even through a glass it seems to be clear, but it is even more luminous and does not appear as transparent. It is probably best compared with the surface of very smooth ice (mirror surface ice). This phenomenon again shows that a competition which results in luminosity production can occur. Neither of the two, neither the black nor the white fence dominate. There is also the tendency to displace the two fences which are located in different planes, so that they will be in the same plane. If the observer approaches closer to the black fence, then the luminosity effect will diminish. Both colors no longer lie in the same plane. The observer now sees right through the first dark fence. The nearer object dominates and the luminosity does not occur.

Other observations with other fences always again show that luminosity always occurs if neither of the two objects dominates. For example, luminosity is also observed if two black fences behind each other are observed. In this case, the apparent "light reflections" which seem to hover above them are not as quiet, especially if the observer is moving. /242

As soon as one of the two visual objects located behind each other dominates, the luminosity phenomenon disappears. For example if a house attracts the attention so much that one hardly notices a fence in front of it, then no luminosity occurs. This is because the house and the fence no longer are in competition with each other.

Conditions are different if there is a homogeneous background behind a fence which will not attract the optical attention as much as a wall of a house or if the fence stands alone or dominates the visual field so much that it can compete with objects behind it. In this case one observes that the air between the fence posts has the appearance of a glass-like skin, similar to the surface of a soap bubble. The colors behind it are observed just like through a thin glass plate especially if the fence posts stand off in a noticeable way and are not too far apart. We are then dealing with the transparency with a slight tendency to luminosity, similar to the "glass-like" impression that Schumann stresses. In fact, the statements of our test persons then coincide with the statements of Schumann. The luminosity phenomenon apparently is caused by the fact that the observer looks through the fence on to objects located behind it and both are in competition.

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16. Abstract

Experiments on the apparent intermediate medium between observer and visual objects are described. These were carried out in rooms having two chambers, subjected to different lighting conditions. Experiments were also carried out in nature.

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